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GLOBAL VAN-CONG EFFECTIVE KINETIC, GRAVITATIONAL POTENTIAL, AND TOTAL ENERGIES, OBTAINED IN THE GEOSTATIONNARY SATELLITE (GS) − EARTH INTERACTION SYSTEM, AND ENHANCED BY OUR EMPIRICAL GLOBAL EFFECTIVE KINETIC MASS OF THIS GS, EXPRESSED AS A FUNCTION OF ANY SPEED (OR ANY RELATIVITY) (40)

Prof. Dr. Huynh Van Cong*

Université de Perpignan Via Domitia, Laboratoire de Mathématiques et Physique (LAMPS), EA 4217, Département de Physique, 52, Avenue Paul Alduy, F-66 860 Perpignan, France.

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***Corresponding Author**

Prof. Dr. Huynh Van Cong

Université de Perpignan Via Domitia, Laboratoire de Mathématiques et Physique (LAMPS), EA 4217, Département de Physique, 52, Avenue Paul Alduy, F-66 860 Perpignan, France.

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ABSTRACT

In this work, we present the new expressions of global effective kinetic, gravitational potential and total energies, obtained in the Geostationary Satellite (GS)-Earth interaction system, as those given in Equations (4, 5, 6), and enhanced by a new global effective kinetic mass of the GS, as that given in Eq. (1). Some concluding remarks are given as follows. At the low speed v (<< c), c being the light speed, given in the non-relativistic case, they are found to be correct. At v=c, given in the relativistic case, the kinetic energy is found to be equal to: $m \times c^2 \times \left[\frac{2+p}{4}\right]$, for $p > 0$, and, in particular, for p=2, to: $m \times c^2$, in good accordance with that proposed by Einstein in 1905 [1], m being the rest mass of the GS, as those shown in Table 1.

KEYWORDS: Global effective kinetic-potential-total energies, global effective kinetic mass, light speed, relativity, non-relativity.

First of all, from the expression of the kinetic energy of Geostationary Satellite (GS), with its rest mass $\mathbf{m}(= \mathbf{5060\ Kg})$, in motion with a speed v, being equal to the light speed $\mathbf{c}= \mathbf{2.9979} \times \mathbf{10^8}\ (\frac{m}{s})$, $\frac{2m\times c^2}{2}$, given by Einstein in 1905 [1-3], we now propose its **gobal effective kinetic mass**, valid at any v, by [4] :

$$m^*(v; p > 0) = m \times (1 + p \times \frac{v^2}{c^2}), (1)$$

being increased with increasing v, and noting that at lowest v: $m^*(v; p) \simeq m$, given in the non-relativistic case, and then, at v=c, given in the relativistic case: $m^*(v = c; p) = m \times (1 + p)$.

Then, from Eq. (1), this GS is in motion, due to the **global effective Newton force**:

$$F^*_{GEN}(v; p) \equiv m^*(v; p) \times \frac{dv}{dt} = m \times \left(1 + p \times \frac{v^2}{c^2}\right) \times \frac{dv}{dt}, \quad (2)$$

where $\frac{dv}{dt}$ is its acceleration. Further, it is attracted by the Earth of the mass $\mathbf{M} = \mathbf{5.97219} \times \mathbf{10^{24}\ kg}$, due to the **global effective gravitational force**, defined by:

$$F^*_{GEG}(v; p) \equiv -\frac{GMm^*(v;p)}{r^2} = -\frac{GMm\times(1+p\times\frac{v^2}{c^2})}{r^2}, \qquad (3)$$

where r is the distace between the GS and the Earth, and $\mathbf{G} = \mathbf{6.6743} \times \mathbf{10^{-11}}\ \frac{\mathbf{m^3}}{\mathbf{kg\times s^2}}$ is the universal gravitational constant.

From Eq. (2), noting that $\frac{dv}{dt} \times dr = vdv$, our **global effective kinetic energy** is defined by:

$$K^*(v; p) \equiv \int F^*_{GEN}(v; p) \times dr = \int m \times \left(1 + p \times \frac{v^2}{c^2}\right) \times vdv = m \times v^2 \times \left[\frac{2+p\times\frac{v^2}{c^2}}{4}\right]. \ (4)$$

Eq. (4) is reduced to the correct result at the lowest v ($\ll$ c) as: $\frac{m\times v^2}{2}$, given in the non-relativistic case, and at v=c, given in the relativistic case, to: $K_o(p) \equiv m \times c^2 \times \left[\frac{2+p}{4}\right]$, which gives rise to a following assumption, by putting: x=$\frac{2+p}{4}$.

If x is known, then p is determined by : p=4x−2.

For example, **(i)** if x=3/4, then p=1, accoding to : $K_o(p = 1) = (\frac{3}{4}) \times mc^2$, **(ii)** if x=1, then p=2, accoding to : $\mathbf{K_o(p = 2) = mc^2}$, in good accordance with that proposed by Einstein in the relativistic case [1], (iii) if x=5/4, then p=3, accoding to : $K_o(p = 3) = (\frac{5}{4}) \times mc^2$, and so on. This assumption is used to determine $K_o(p)$, given in next Table 1 in Appendix 1.

Further, from Eq. (3), our global effective gravitational energy, $U^*(v, r; p)$, is defined by:

$$U^*(v, r; p) \equiv -\int_{\infty}^{r} F^*_{GEG}(v; p) \times dx \equiv -\int_{\infty}^{r} -\frac{GMm^*(v;p)}{x^2} dx = -\frac{GMm^*(v;p)}{r} = -\frac{GMm\times(1+p\times\frac{v^2}{c^2})}{r},$$

being reduced to the correct result at the lowest v ($\ll$ c) as: $= -\frac{GMm}{r}$, given in the non-relativistic case, and at v=c, to: $-\frac{GMm\times(1+p)}{r}$, given in the relativistic case.

Here, we choose: $r = \mathbf{r_{GS}} = \mathbf{35786 \times 10^3\ m}$, being the distance from the GS to the Earth at **Perihelion** (or at **Aphelion**), and $v_{GS} \le v \le c$, $\mathbf{v_{GS}} = \mathbf{3.1 \times 10^3} \left(\frac{\mathbf{m}}{\mathbf{s}}\right)$, being the GS speed at **Perihelion** (or at **Aphelion**).That gives : $U^*(v; p) = -\frac{GMm\times(1+p\times\frac{v^2}{c^2})}{r_{GS}}$, (5)

according at v=c to: $U_o(p) \equiv= -\frac{GMm\times(1+p)}{r_{GS}}$, given in the relativistic case.

Therefore, from Equations (4, 5), the **global effective total enegy**, $E^*(v; p)$, is found to be given by:

$$E^*(v; p) \equiv m \times v^2 \times \left[\frac{2+p\times\frac{v^2}{c^2}}{4}\right] - \frac{GMm\times(1+p\times\frac{v^2}{c^2})}{r_{GS}}, \qquad (6)$$

according at v=c to: $E_o(p) = K_o(p) + U_o(p) = m \times v^2 \times \left[\frac{2+p}{4}\right] - \frac{GMm\times(1+p)}{r_{GS}}$.

Furthermore, it is interesting to evaluate the relative errors between $K^*(v; p)$ and $E^*(v; p)$, defined by:

$$RE(v; p) \equiv 1 - \frac{E^*(v;p)}{K^*(v;p)}. \qquad (7)$$

Then, in following Table 1 in Appendix 1, the numerical results of $RE(v; p)$, $K^*(v; p)/K_o(p)$, $U^*(v; p)/U_o(p)$ and $E^*(v; p)/E_o(p)$ are obtained for p=1, 2 and 3, respectively, using Equations (7, 4, 5, 6), noting that, for a given p, $RE(v; p)$ decreases with increasing v, and at v=c one obtains $K^*(v; p) \cong E^*(v; p)$, with a precision of the order of 3.966×10^{-10}.

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APPENDIX 1

Table 1. In the **Geostationary Satellite-Earth interaction system**, in which the values of m, r_{GS} and v_{GS} are given in above Table 1, the numerical results of $RE(v;p)$, $K^*(v;p)/K_o(p)$, $U^*(v;p)/U_o(p)$ and $E^*(v;p)/E_o(p)$, are obtained by using Equations (7, 4, 5, 6), respectively, noting that $v_{GS} \leq v \leq c$.

X(v)=v/c	$RE(v;p)$	$K^*(v;p)/K_o(p)$	$U^*(v;p)/U_o(p)$	$E^*(v;p)/E_o(p)$
Here, for **p=1** and at v=c, $K_o(p) = \left(\frac{3}{4}\right) \times mc^2 = 3.410719974 \times 10^{20}$ J, $U_o(p) = -1.12721483 \times 10^{11}$ J and $E_o(p) = 3.4107199725 \times 10^{20}$ J, suggesting that $E_o(p) \cong K_o(p)$, with a precision of the order of 3.30491745× 10^{-10}.				
1.03406×10^{-5}	**2.31810334**	**7.12849487× 10^{-11}**	**0.50**	**-9.3960929× 10^{-11}**
0.09	3.07245230× 10^{-8}	0.00542187	0.50405	0.00542187
0.30	2.87269553× 10^{-9}	0.0627	0.545	0.0627
0.40	1.66393421× 10^{-9}	0.1152	0.58	0.1152
0.60	7.93553667× 10^{-10}	0.2832	0.68	0.2832
0.80	4.81184759× 10^{-10}	0.5632	0.82	0.5632
0.90	3.94220434× 10^{-10}	0.7587	0.905	0.7587
0.95	3.60045327× 10^{-10}	0.87316875	0.95125	0.87316875
1	3.30491745× 10^{-10}	**1**	**1**	**1**
Here, for **p=2** and at v=c, $\mathbf{K_o(p) = mc^2 = 4.54762663100 \times 10^{20}}$ **J**, in good agreement with that, proposed by **Einstein in 1905**, $U_o(p) = -1.69082225 \times 10^{11}$ J and $E_o(p) = 4.5476266298 \times 10^{20}$ J, suggesting that $E_o(p) \cong K_o(p)$, with a precision of the order of 3.71803255× 10^{-10}.				
1.03406×10^{-5}	**2.31810334**	**5.34637115× 10^{-11}**	**0.33333333**	**-7.04706968× 10^{-11}**
0.09	3.08469656× 10^{-8}	0.00408281	0.33873333	0.00408280
0.30	2.98150049× 10^{-9}	0.04905	0.39333333	0.04905
0.40	1.76286019× 10^{-9}	0.0928	0.44	0.0928
0.60	8.70781003× 10^{-10}	0.2448	0.57333333	0.2448
0.80	5.38434630× 10^{-10}	0.5248	0.76	0.5248
0.90	4.42954895× 10^{-10}	0.73305	0.87333333	0.73305
0.95	4.04932754× 10^{-10}	0.85850312	0.935	0.85850312
1	3.71803255× 10^{-10}	**1**	**1**	**1**
Here, for **p=3** and further at v=c, $K_o(p) = \frac{5}{4} \times mc^2 = 5.6845332890 \times 10^{20}$ J , $U_o(p) = -2.25442966 \times 10^{11}$ J and $E_o(p) = 5.6845332871 \times 10^{20}$ J, suggesting that $E_o(p) \cong K_o(p)$, with a precision of the order of 3.96590094× 10^{-10}.				
1.03406×10^{-5}	**2.31810334**	**4.27709692× 10^{-11}**	**0.25**	**-5.63765575× 10^{-11}**
0.09	3.09684285× 10^{-8}	0.00327937	0.256075	0.00327937
0.30	3.08167780× 10^{-9}	0.04086	0.3175	0.04086

0.40	1.84902149×10^{-9}	0.07936	0.37	0.07936
0.60	$9.29955113\times 10^{-10}$	0.22176	0.52	0.22176
0.80	$5.76990566\times 10^{-10}$	0.50176	0.73	0.50176
0.90	$4.73867945\times 10^{-10}$	0.71766	0.8575	0.71766
0.95	$4.32609060\times 10^{-10}$	0.84970375	0.926875	0.84970375
1	$3.96590094\times 10^{-10}$	**1**	**1**	**1**